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(54) Gas turbine inlet air cooling system

Kühlsystem für die Eintrittsluft in eine Gasturbine

Système de refroidissement du flux d'air d'entrée d'une turbine à gaz

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Description

Background of the Invention

The present invention relates to apparatus for cooling gas turbine intake air using fuel for driving the gas turbine such as liquified natural gas (hereunder, referred to as LNG) and to a method of cooling intake air for a gas turbine.

Recently, combined power plants using gas turbines have increased in use for power supply as compared with conventional steam power plants because the former is higher in efficiency than the latter.

In gas turbines a large amount of air is taken in by a rotary compressor and its output is generated by expanding the air, so that the specific gravity of the air greatly influences the output. The higher the atmospheric temperature, the smaller the specific gravity of the air becomes, and the gas turbine has a characteristic that its output decreases as well. On the other hand, since the peak of electric power demand is in summer, power is required much more in summer when the atmosphere temperature is high. This is contrary to the characteristic of the gas turbine. It is necessary to effectively supply electric power without decreasing power generation of the gas turbine even if the atmosphere temperature is high.

According to such a demand, a gas turbine intake air cooling method is proposed, wherein decrease in gas turbine output in summer is prevented by lowering the gas turbine intake air temperature below atmosphere temperature and supplying the cooled intake air. Japanese Utility-Model Publication No. 61-37794 discloses a method in which LNG cold lowers temperature of brine as a heat medium, the brine is brought into direct contact with gas turbine intake air to lower the temperature thereof. Japanese Patent Laid-open Application No. 1-142219 discloses a method in which LNG cold lowers a temperature of a heat medium and the heat medium lowered in temperature cools directly gas turbine intake air or indirectly cools the gas turbine intake air using another heat medium. In the laid-open application, it is described that water or mixture of ethylene glycol and water for instance is used the heat mediums.

In the former method above using the brine as a heat medium directly contacting with LNG cold, the brine is liable to be easily frozen because of a temperature difference between a boiling temperature -162°C of LNG and a solidifying point -22°C of the brine, which is a bar to recirculation of the brine. The latter method above also has a similar problem.

Further, since the peak of power demand is in summer, particularly in the daytime of summer, it is desirable to cool gas turbine intake air by using cold of a heat accumulator in the daytime thereby to effect heat dissipation operation of the heat accumulator for increasing output of the gas turbine and to effect heat accumulation of LNG cold in the nighttime because cold for cooling the gas turbine intake air is unnecessary or smaller than in the daytime. However, it is difficult for conventional heat accumulators to carry out a lot of heat dissipation and heat accumulation at the same time because of insufficient capacity of the heat accumulators.

Summary of the Invention

An object of the present invention is to provide an apparatus for cooling gas turbine intake air by using safely cold heat of fuel such as LNG while preventing a heat medium from being frozen in a portion not required to freeze.

Another object of the present invention is to provide a gas turbine intake air cooling apparatus which is able to effect a lot of heat dissipation and heat accumulation of a heat accumulator at the same time.

Apparatus for cooling intake air for a gas turbine using the fuel for the gas turbine according to the present invention is as set out in claim 1.

In one preferred embodiment of the invention, the first intermediate heat medium is condensable by the fuel cold and vaporizable by the heat medium, the first intermediate heat medium has a solidifying point lower than the fuel.

Suitably, the apparatus has a pressure controller for controlling the pressure within the heat exchanger so that the temperature of the first intermediate heat medium is kept higher than its solidifying point.

In a preferred embodiment of the present invention, the intake air cooler has a heat accumulator having therein a further heat medium for accumulating the cold heat from the second intermediate heat medium cold, and an intake air cooling means for cooling intake air to be introduced into the gas turbine with accumulated cold.

Preferably the heat accumulator comprises a plurality of heat accumulator modules separated fluidly from each other, each of which heat accumulator modules has fluid lines for the heat medium with valves for receiving the heat medium cold from the heat exchanger and further fluid lines for the further heat medium with valves for transmitting the accumulated cold of the further heat medium to the intake air cooling means to cool the intake air. The plurality of heat accumulator modules are operated so that heat accumulation and heat dissipation in at least one of the plurality of heat accumulator modules are switched according to a cold demand required for the intake air cooler.

"Cold" used herein means a state of energy of a substance in a lower temperature side than an atmosphere temperature.

Brief Description of the Drawings

Fig. 1 is a schematic diagram of a gas turbine intake air cooling apparatus of a first embodiment of the present invention;

Fig. 2 is a temperature diagram of a first heat exchanger used in the gas turbine intake air cooing apparatus shown in Fig. 1;

Fig. 3 is a temperature diagram of a heat accumulator used in the gas turbine intake air cooling apparatus shown in Fig. 1;

Fig. 4 is a temperature diagram of an intake air cooler used in the gas turbine intake air cooing apparatus shown in Fig. 1;

Fig. 5 is a diagram showing a relationship between gas turbine intake air and output of the gas turbine in the first embodiment;

Fig. 6 is a schematic diagram of a gas turbine intake air cooling apparatus of a second embodiment of the present invention; and

Fig. 7 is a schedule diagram of a heat accumulator module operation in the second embodiment.

Detailed Description of Embodiments of the Invention

An embodiment (simply referred to a first embodiment) of the present invention is described hereunder referring to Figs. 1 to 5.

In Fig. 1, a gas turbine 15 comprises a compressor 15a, a gas turbine part 15b and a combustor 15c. The compressor 15a takes in air to compress and supply it to the combustor 15c to effect combustion of fuel supplied thereto and mixed with the compressed air to form combustion product. The combustion product drives the gas turbine part 15b which drives a load 16 such as an electric generator.

Air to be taken or introduced into the compressor 15a, that is, intake air for the gas turbine 15 is cooled by means of the cold heat of the fuel and then the cooled intake air is supplied to the gas turbine 15. In this embodiment, LNG is used as a fuel, and cold heat of LNG is used for cooling the intake air 13 for the gas turbine 15.

Apparatus for cooling gas turbine intake air of the first embodiment comprises a first heat exchanger 4, a second heat exchanger 8 and an intake air cooler 10. The first heat exchanger 4 is provided with a part of pipe line 3 and a pressure controller 30 and contains therein propane as a first intermediate heat medium. Pressure in the inside of the heat exchanger 4 is controlled by the pressure controller 30 to be always constant, so that the propane is separated in two phases, a gas phase 5 and a liquid phase 6 at a saturated temperature corresponding to the controlled pressure. The pipe line 3 is led from a LNG tank 1 containing therein LNG as a fuel to the gas turbine 15 through the first heat exchanger 4. The LNG 2 led to the first heat exchanger 4 is converted therein from liquid phase to a gas phase, with the LNG receiving gasification heat from the propane of gas phase. The vaporized LNG is led to the gas turbine 15 to be served as fuel therefor. The propane 5 of gas phase loses its latent heat through heat exchange with the LNG and turns into propane 6 of liquid phase, that is, propane vapor is condensed.

The second heat exchanger 8 is provided with a spray device at an upper side thereof and contains therein water as a third intermediate heat medium. The water is recirculated by a pump 12 provided on a pipe line 9 through the pipe line 9. A part of the pipe line 9 is arranged within the interior of the intake air cooler 10 to contact with an intake air 13 for the gas turbine to cool the air and cooled air is supplied into the gas turbine 15 through an intake pipe 14.

A recirculation line 7 is provided between the first and second heat exchangers 4 and 8 so that a part thereof is disposed in the propane 6 of liquid phase in the first heat exchanger 4 and another part is disposed in the water in the second heat exchanger 8. The recirculation line 7 comprises a looped pipe and a pump 11 mounted on the pipe. Brine 17 as a second intermediate heat medium is contained in the pipe and recirculated by the pump 11. The brine entering the first heat exchanger 4 through the second heat exchanger 8 is lowered in temperature by the propane 6 of liquid phase, and the propane 6 receives a heat amount corresponding to a heat amount spent for lowering the brine, as gasification heat, so that the propane 6 is vaporized to be propane 5 of gas phase. These heat relations are shown in Fig. 2.

In Fig. 2, T_1, T_2 represent an inlet temperature and an outlet temperature of LNG of the first heat exchanger 4, respectively. T_3 represents a working temperature which is a saturation temperature of the propane. T_4, T_5 represent an inlet temperature and an outlet temperature of the brine at the first heat exchanger 8.

Since boiling temperature of the propane in the first heat exchanger 4 can be raised to a temperature higher than a solidification temperature -22°C of the brine by controlling the pressure of the propane to a suitable one by the pressure controller 30, the brine can be prevented from being frozen. The pressure controller 30 is provided with pressure sensor 30a, and a valve 30b mounted on a passage for propane of gas phase and/or a valve 30c mounted on a passage for propane of liquid phase. The pressure sensor 30a detects pressure in the first heat exchanger 4, and the pressure controller 30 controls pressure in the first heat exchanger 4 by operation of the valve 30b, 30c so as to introduce or discharge propane of gas phase and/or liquid phase so that the detected pressure will be a target pressure. It is possible to associate feedback control for the pressure control.

Further, since the latent heat of the propane is two or three times the latent heat of LNG or the brine, it is possible to make the size of the first heat exchanger 4 smaller.

Further, the brine lowered in temperature in the first heat exchanger 4 by the propane is sent to the second heat exchanger 8 through the recirculation line 7. The water in the second heat exchanger 8 is lowered in temperature and made into ice, so that the second heat exchanger 8 contains therein water and ice. Since the propane is the first intermediate heat medium, the working

temperature range of the brine can be approached near a temperature of ice, as shown in Figs 2 and 3. By causing the working temperature range of the brine to approach near the ice temperature, it is possible to damp thermal shock of ice-making apparatus and pipings. In Fig. 3, T_6, T_7 are inlet temperature and outlet temperature of the brine at the second heat exchanger 8, respectively. T_8 represents a freezing temperature of water in the second heat exchanger 8.

The water is recirculated in the pipe line 9 between the second heat exchanger 8 and the intake air cooler 10 to lower the temperature of atmosphere or air 13 introduced into the intake air cooler 10. The cooled air is introduced into the gas turbine 15 as an intake air for the gas turbine through the intake pipe 14.

Fig. 4 shows relations among air temperatures at the inlet and outlet of the intake air cooler 10, water temperature at the outlet of the second heat exchanger 8 and water temperature after heat-exchanging in the intake air cooler 10. T_9, T_{10} are the inlet temperature and the outlet temperature of water at the intake air cooler 10, respectively, and T^{11}, T_{12} represent the inlet temperature and the outlet temperature of air at the intake air cooler 10, respectively.

In Fig. 5, in case that the inlet temperature T_{11} of air at the intake air cooler 10 and the outlet temperature T_{12} of the air at the intake air cooler 10 are 33°C and 15°C, respectively, output of the gas turbine 15 can be increased by about 10%.

As apparent from the above description, the cold heat of the brine is accumulated in the second heat exchanger 8 as ice and cold water, so that the second heat exchanger 8 serves as a heat accumulator. Further, the heat accumulator and the intake air cooler constitutes a cooling system for air to be introduced into the gas turbine 15, wherein the heat accumulator is a cold source for the intake air cooler 10, and the pipe line 9 is a second recirculation line for recirculating the third intermediate heat medium 18.

The propane has a solidifying point of -190°C which is lower than a solidifying point (-162°C) of LNG. Methane, ethane, carbon tetrafluoride, etc. can be used for the first intermediate heat medium instead of propane. Examples of brine (i.e. a solution of a component in water) as a second intermediate heat medium are calcium chloride water solution, ethylene glycol water solution, propylene glycol water solution, etc.

Another embodiment (second embodiment) is described hereunder, referring to Figs. 6 and 7.

A principle construction of an apparatus for cooling gas turbine intake air with vaporization heat of LNG as a cold source, in the second embodiment, is the same as one of the first embodiment. However, the second heat exchanger 8 of the first embodiment is different from a second heat exchanger 8a of the second embodiment and the difference causes modification of the recirculation lines 7 and 9.

In Fig. 6, the second heat exchanger 8a is a heat accumulator comprising a plurality of heat accumulator modules 19 to 22 fluidly separated from each other, each of which accumulates and dissipates the cold heat of the second intermediate heat medium cold recirculating in the recirculation line 7a having branch line parts 71, 72. First to fourth heat accumulator modules 19 to 22 are stacked as shown in Fig. 6. Each heat accumulator module 19 to 22 is connected to the recirculation line 7a through branch line parts 71, 72 each of which has a first flow regulation valve 23 mounted thereon, and to the recirculation line 9a through branch lines 91, 92 each of which has a second flow regulation valve 24 mounted thereon.

An amount of recirculation of the second intermediate heat medium for each heat accumulator module 19-22 is determined by flow rate of the pump 11 and opening degree of the first flow regulation valves 23. An amount of recirculation of the third intermediate heat medium in each heat accumulator module from the heat accumulator module to the intake air cooler 10 is determined by flow rate of the pump 12 and opening degree of the second flow regulation valves 24.

An example of operation schedule of the heat accumulator modules 19-22 is shown in Fig. 7. In this example, a gas turbine intake air cooling operation by thawing ice of the second heat exchanger 8a is effected for three hours in the daytime, and ice-making is effected in the second heat exchanger 8a for remaining 21 hours.

Since the second heat exchanger 8a has the four heat accumulator modules 19 to 22, in order to execute ice-thawing operation for three hours, each heat accumulator module executes the ice thawing operation in turns according to the operation schedule as shown in Fig. 7.

For example, in case the first heat accumulator module 19 effects ice-thawing operation, the first flow regulation valves 23 of the first heat accumulator module 19 are closed and the first flow regulation valves 23 of the remaining heat accumulator modules 20 to 22 are opened. Further, the second flow regulation valves 24 of the first heat accumulator module 19 are opened and the remaining second flow regulation valves 24 are closed. A series of valve switching operation is effected in turn from the first heat accumulator module 19 to the fourth heat accumulator module 22, whereby three hours gas turbine intake air cooling operation can be executed. In this embodiment, the first to fourth heat accumulator modules 19 to 22 are changed over to operate in turn, however, any switching order of the operation of the heat accumulator modules 19 to 22 can be taken.

According to this embodiment, irrespective of each heat accumulator module operating ice-making or thawing, the ice-making and thawing are effected at the same time as a whole heat accumulator 8a, so that a lot of the third intermediate heat medium can be treated (served for heat exchanging). Further, accumulation and dissipation of cold can be carried out according to an amount

of cold required for the intake air cooler 10.

According to the present invention, the apparatus for cooling gas turbine intake air with LNG can prevent the heat medium or heat mediums directly or indirectly cooling the gas turbine intake air from being frozen, so that the LNG cold can be safely and effectively used to cool the gas turbine intake air. Further, even in summer when atmosphere temperature is high, power can be supplied stably without lowering its power generation efficiency.

Further, ice-making operation and ice thawing operation can be carried out in the heat accumulator at the same time and a lot of the heat medium can be treated. The ice-making and ice thawing can be executed according to an amount of cold required for the intake air cooler to cool the air.

Claims

1. Apparatus for cooling intake air for a gas turbine (15) using the fuel for the gas turbine, comprising:

    a first heat exchanger (4) for transmitting the cold heat of the fuel to a first intermediate heat medium (5, 6),
    a second heat exchanger (4) for heat exchange between said first intermediate heat medium (5,6) and a second intermediate heat medium (17), and
    an intake air cooler (8,10) for cooling the intake air by using the cold heat of said second intermediate heat medium,

    characterized in that said first intermediate heat medium (5,6) has a property different from said second intermediate heat medium.

2. Apparatus according to claim 1, wherein said first intermediate heat medium (5,6) is condensed by the cold heat of the fuel and vaporized by said second intermediate medium (17).

3. Apparatus according to claim 2, wherein said intake air cooler comprises a heat accumulator (8,8a) for accumulating therein the cold heat of said second intermediate heat medium (17) and an intake air cooling means (9,10,18) for cooling the intake air using accumulated cold heat in said accumulator (8).

4. Apparatus according to claim 3, wherein said first and second heat exchangers (4) have said first intermediate heat medium contained therein and a portion of a fuel line (3) carrying said fuel arranged so as to contact the gas phase of said first intermediate heat medium, said second intermediate heat medium (17) is in a recirculation line (7) arranged so as to contact the liquid phase of said first intermediate heat medium there being a third intermediate heat medium in said heat accumulator (8) contacted by said recirculation line (7).

5. Apparatus according to claim 4, wherein said second and third intermediate heat mediums have different properties.

6. Apparatus according to claim 5, wherein said second intermediate heat medium (17) is brine and said third intermediate heat medium is water.

7. Apparatus according to any one of claims 4 to 6, wherein said intake further comprising:

    a second recirculation line (8) for recirculating said third intermediate heat medium between said heat accumulator (8) and said air cooler (10) to cool the intake air for the gas turbine.

8. Apparatus according to any one of claims 3 to 7, wherein said heat accumulator (8a) comprises a plurality of heat accumulator modules (19,20,21,22) separated from each other in respect of their fluid flows, said heat accumulator modules having respective fluid lines with valves (23) connecting them to a recirculation line (7a) for said second intermediate heat medium, and further respective fluid lines with valves (24) connecting them to said intake air cooling means (10).

9. Apparatus according to any one of claims 1 to 8, wherein said first intermediate heat medium has a solidifying point lower than that of the fuel.

10. Apparatus according to claim 9, wherein said first heat exchanger has a pressure controller for controlling the pressure of said first intermediate heat medium so as to keep said first intermediate heat medium at a higher temperature than its solidifying point.

11. Method of cooling intake air for a gas turbine (15) using fuel for the gas turbine, comprising transmitting cold heat of the fuel to a second intermediate heat medium (17) through a first intermediate heat medium (5,6) and cooling the intake air to be introduced into the gas turbine by the cold heat of said second intermediate heat medium, characterized in that said first and second intermediate heat mediums have different properties.

12. Method according to claim 11, wherein said first intermediate heat medium (5,6) is condensed by the cold heat of the fuel and vaporized by said second intermediate heat medium (17).

13. Method according to claim 11 or 12, wherein cold heat of said second intermediate heat medium is stored in an accumulator (8) and said intake air is cooled by a third intermediate medium which undergoes heat exchange with said second intermediate heat medium (17) in said accumulator (8).

Patentansprüche

1. Vorrichtung zum Kühlen von Ansaugluft für eine Gasturbine (15) mittels des Brennstoffes für die Gasturbine, mit

   einem ersten Wärmetauscher (4) zum Übertragen der Kühlungswärme auf ein erstes Zwischen-Wärmemedium (5, 6),
   einem zweiten Wärmetauscher (4) zum Wärmetauschen zwischen dem ersten Zwischen-Wärmemedium (5, 6) und einem zweiten Zwischen-Wärmemedium (17), und
   einem Ansaugluft-Kühler (8, 10) zum Kühlen der Ansaugluft mittels der Kühlungswärme des zweiten Zwischen-Wärmemediums,

   dadurch **gekennzeichnet**, daß das erste Zwischen-Wärmemedium (5, 6) sich bezüglich einer Eigenschaft von dem zweiten Zwischen-Wärmemedium unterscheidet.

2. Vorrichtung gemäß Anspruch 1, wobei das erste Zwischen-Wärmemedium (5, 6) durch die Kühlungswärme des Brennstoffes kondensiert und durch das zweite Zwischenmedium (17) verdampft wird.

3. Vorrichtung gemäß Anspruch 2, wobei der Ansaugluft-Kühler einen Wärmespeicher (8, 8a) zum Speichern der Kühlungswärme des zweiten Zwischen-Wärmemediums (17) und eine Ansaugluft-Kühlungseinrichtung (9, 10, 18) zum Kühlen der Ansaugluft mittels der im Speicher (8) gespeicherten Kühlungswärme aufweist.

4. Vorrichtung gemäß Anspruch 3, wobei der erste und der zweite Wärmetauscher (4) das erste Zwischen-Wärmemedium enthalten und einen Abschnitt einer den Brennstoff führenden Brennstoffleitung (3) aufweisen, der so angeordnet ist, daß er in Kontakt mit der Gasphase des ersten Zwischen-Wärmemediums steht, wobei das zweite Zwischen-Wärmemedium (17) sich in einer Umwälzleitung (7) befindet, die so angeordnet ist, daß sie in Kontakt mit der flüssigen Phase des ersten Zwischen-Wärmemediums steht, wobei ein drittes Zwischen-Wärmemedium im Wärmespeicher (8) durch die Umwälzleitung (7) kontaktiert wird.

5. Vorrichtung gemäß Anspruch 4, wobei das zweite und das dritte Zwischen-Wärmemedium unterschiedliche Eigenschaften zeigen.

6. Vorrichtung gemäß Anspruch 5, wobei das zweite Zwischen-Wärmemedium (17) Sole und das dritte Zwischen-Wärmemedium Wasser ist.

7. Vorrichtung gemäß einem der Ansprüche 4 bis 6, wobei die Ansaugung

   eine zweite Umwälzleitung (8) zum Umwälzen des dritten Zwischen-Wärmemediums zwischen dem Wärmespeicher (8) und dem Luftkühler (10) zum Kühlen der Ansaugluft für die Gasturbine aufweist.

8. Vorrichtung gemäß einem der Ansprüche 3 bis 7, wobei der Wärmespeicher (8a) eine Vielzahl von Wärmespeicher-Module (19, 20, 21, 22) aufweist, die voneinander in bezug auf ihre Fluidströme getrennt sind, wobei die Wärmespeicher-Module jeweils Fluid-Leitungen mit Ventilen (23), die sie mit einer Umwälzleitung (7a) für das zweite Zwischen-Wärmemedium verbinden, und jeweils weitere Fluidleitungen mit Ventilen (24), die sie mit der Ansaugluft-Kühlungseinrichtung (10) verbinden, aufweisen.

9. Vorrichtung gemäß einem der Ansprüche 1 bis 8, wobei das erste Zwischen-Wärmemedium einen Erstarrungspunkt aufweist, der niedriger liegt als der des Brennstoffes.

10. Vorrichtung gemäß Anspruch 9, wobei der erste Wärmetauscher einen Druckregler zum Regeln des Drucks aufweist, so daß das erste Zwischen-Wärmemedium auf einer Temperatur gehalten wird, die höher ist als sein Erstarrungspunkt.

11. Verfahren zum Kühlen von Ansaugluft für eine Gasturbine (15) mittels Brennstoff für die Gasturbine, wobei Kühlungswärme des Brennstoffes von einem zweiten Zwischen-Wärmemedium (17) über ein erstes Zwischen-Wärmemedium (5, 6) übertragen und die Ansaugluft, die der Gasturbine zugeführt werden soll, durch die Kühlungswärme des zweiten Zwischen-Wärmemediums gekühlt wird, dadurch gekennzeichnet, daß das erste und das zweite Zwischen-Wärmemedium unterschiedliche Eigenschaften besitzen.

12. Verfahren gemäß Anspruch 11, wobei das erste Zwischen-Wärmemedium (5, 6) durch die Kühlungswärme des Brennstoffes kondensiert und durch das zweite Zwischen-Wärmemedium (17) verdampft wird.

13. Verfahren gemäß Anspruch 11 oder 12, wobei Kühlungswärme des zweiten Zwischen-Wärmemediums in einem Speicher (8) gespeichert und die Ansaugluft durch ein drittes Zwischenmedium gekühlt wird, das einem Wärmetausch mit dem zweiten Zwischen-Wärmemedium (17) im Speicher (8) ausgesetzt ist.

Revendications

1. Dispositif pour refroidir de l'air d'admission pour une turbine (15) à gaz à l'aide du combustible pour la turbine à gaz, comprenant:

   un premier échangeur (4) de chaleur servant à transmettre la chaleur froide du combustible à un premier agent de chauffage intermédiaire (5, 6),
   un deuxième échangeur (4) de chaleur servant à échanger de la chaleur entre ledit premier agent de chauffage intermédiaire (5, 6) et un deuxième agent de chauffage intermédiaire (17), et
   un refroidisseur (8, 10) d'air d'admission servant à refroidir l'air d'admission à l'aide de la chaleur froide dudit deuxième agent de chauffage intermédiaire,

   caractérisé en ce que ledit premier agent de chauffage intermédiaire (5, 6) a une propriété différente dudit deuxième agent de chauffage intermédiaire.

2. Dispositif selon la revendication 1, dans lequel ledit premier agent de chauffage intermédiaire (5, 6) est condensé par la chaleur froide du combustible et vaporisé par ledit deuxième agent de chauffage intermédiaire (17).

3. Dispositif selon la revendication 2, dans lequel ledit refroidisseur d'air d'admission comprend un accumulateur (8, 8a) de chaleur dans lequel est destinée à s'accumuler la chaleur froide dudit deuxième agent de chauffage intermédiaire (17) et un moyen (9, 10, 18) de refroidissement d'air d'admission servant à refroidir l'air d'admission à l'aide de chaleur froide accumulée dans ledit accumulateur (8).

4. Dispositif selon la revendication 3, dans lequel lesdits premier et deuxième échangeurs (4) de chaleur contiennent ledit premier agent de chauffage intermédiaire, une partie d'une conduite (3) de combustible transportant ledit combustible conçue pour venir au contact de la phase gazeuse du premier agent de chauffage intermédiaire, ledit deuxième agent de chauffage intermédiaire (17) est dans une conduite de recirculation (7)conçue pour venir au contact de la phase liquide dudit premier agent de chauffage intermédiaire, un troisième agent de chauffage intermédiaire présent dans ledit accumulateur (8) de chaleur étant en contact avec ladite conduite de recirculation (7).

5. Dispositif selon la revendication 4, dans lequel lesdits deuxième et troisième agents de chauffage intermédiaires ont des propriétés différentes.

6. Dispositif selon la revendication 5, dans lequel ledit second agent de chauffage intermédiaire (17) est une saumure et ledit troisième agent de chauffage intermédiaire est de l'eau.

7. Dispositif selon l'une quelconque des revendications 4 à 6, dans lequel ladite admission comprend en outre:

   une deuxième conduite de recirculation (8) pour faire recirculer ledit troisième agent de chauffage intermédiaire entre ledit accumulateur (8) de chaleur et ledit refroidisseur (10) d'air afin de refroidir l'air d'admission pour la turbine à gaz.

8. Dispositif selon l'une quelconque des revendications 3 à 7, dans lequel ledit accumulateur (8a) de chaleur comprend une pluralité de modules (19, 20, 21, 22) d'accumulation de chaleur séparés les uns des autres en ce qui concerne leurs flux de fluide, lesdits modules d'accumulation de chaleur ayant des conduites de fluide respectives avec des vannes (23) qui les relient à une conduite de recirculation (7a) pour ledit deuxième agent de chauffage intermédiaire, et en outre des conduites de fluide respectives avec des vannes (24) qui les relient audit moyen (10) de refroidissement d'air d'admission.

9. Dispositif selon l'une quelconque des revendications 1 à 8, dans lequel ledit premier agent de chauffage intermédiaire a un point de solidification inférieur à celui du combustible.

10. Dispositif selon la revendication 9, dans lequel ledit premier échangeur de chaleur a un régulateur de pression pour réguler la pression dudit premier agent de chauffage intermédiaire afin de maintenir ledit premier agent de chauffage intermédiaire à une température supérieure à son point de solidification.

11. Procédé de refroidissement d'air d'admission pour une turbine (15) à gaz à l'aide du combustible pour la turbine à gaz, comprenant les étapes consistant à transmettre de la chaleur froide du combustible à un second agent de chauffage intermédiaire (17) à

l'aide d'un premier agent de chauffage intermédiaire (5, 6) et à refroidir l'air d'admission destiné à être introduit dans la turbine à gaz à l'aide de la chaleur froide dudit deuxième agent de chauffage intermédiaire, caractérisé en ce que lesdits premier et deuxième agents de chauffage intermédiaires ont des propriétés différentes.

12. Procédé selon la revendication 11, dans lequel ledit premier agent de chauffage intermédiaire (5, 6) est condensé par la chaleur froide du combustible et vaporisé par ledit deuxième agent de chauffage intermédiaire (17).

13. Procédé selon la revendication 11 ou 12, dans lequel la chaleur froide dudit deuxième agent de chauffage intermédiaire est stockée dans un accumulateur (8) et ledit air d'admission est refroidi par un troisième agent de chauffage intermédiaire qui est soumis à un échange de chaleur avec ledit deuxième agent de chauffage intermédiaire (17) dans ledit accumulateur (8).

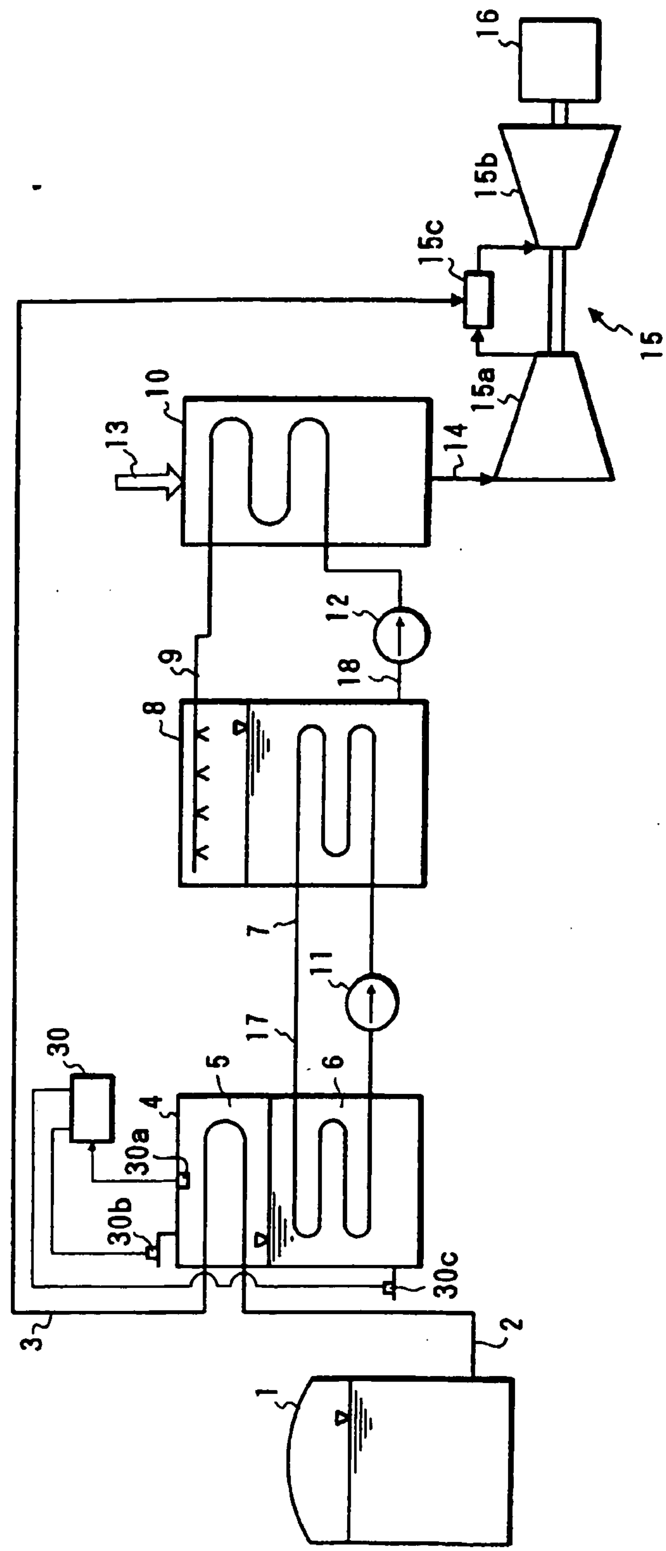


FIG. 1

FIG. 2

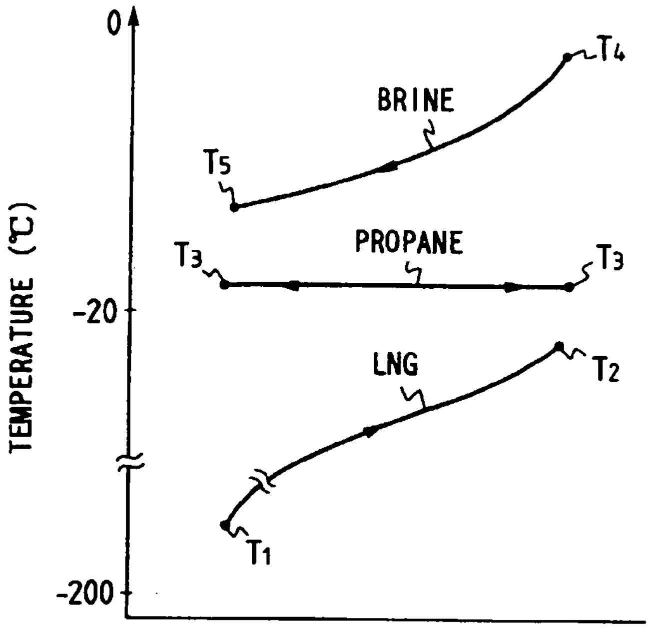

0
-20
-200
TEMPERATURE (℃)
T4
BRINE
T5
PROPANE
T3
T3
LNG
T2
T1

FIG. 3

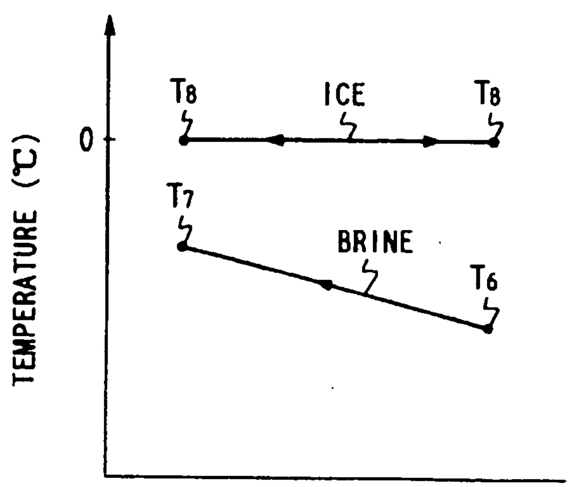

0
TEMPERATURE (℃)
T8
ICE
T8
T7
BRINE
T6

FIG. 4

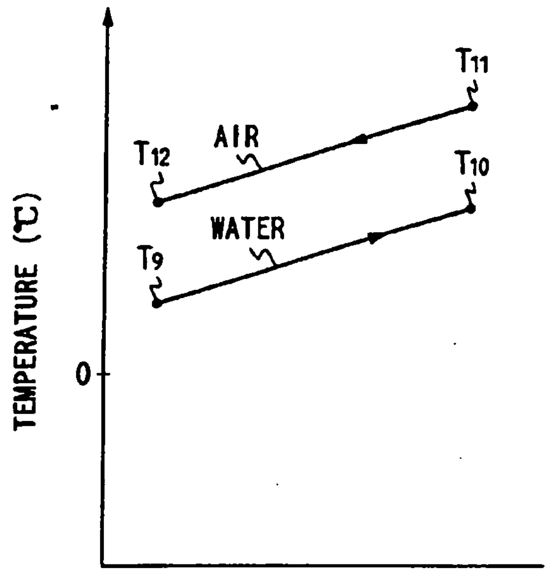

T11
T12
AIR
T10
WATER
T9
0
TEMPERATURE (℃)

FIG. 5

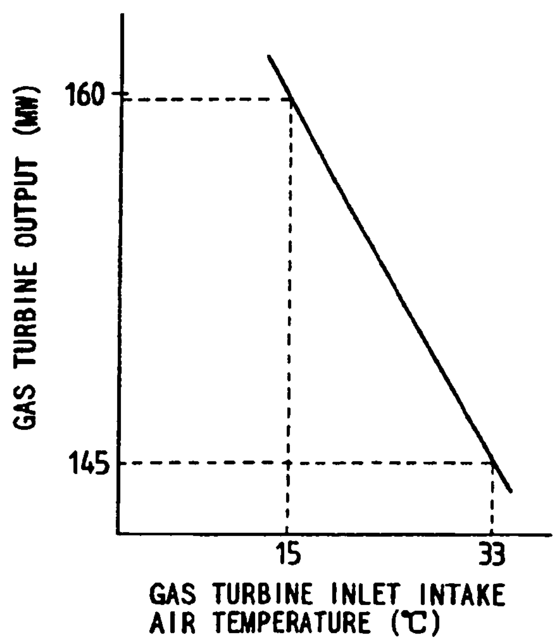

160
145
GAS TURBINE OUTPUT (MW)
15
33
GAS TURBINE INLET INTAKE AIR TEMPERATURE (℃)

FIG. 6

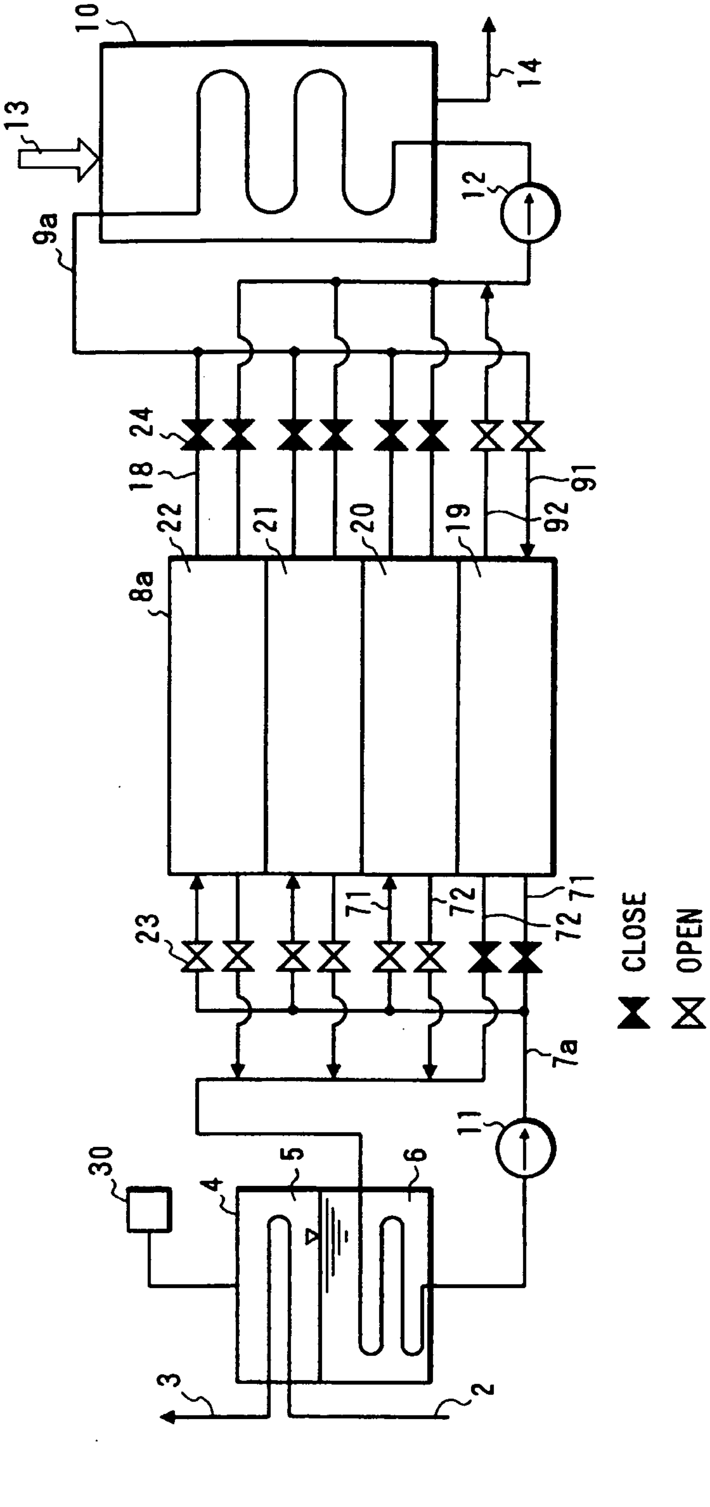
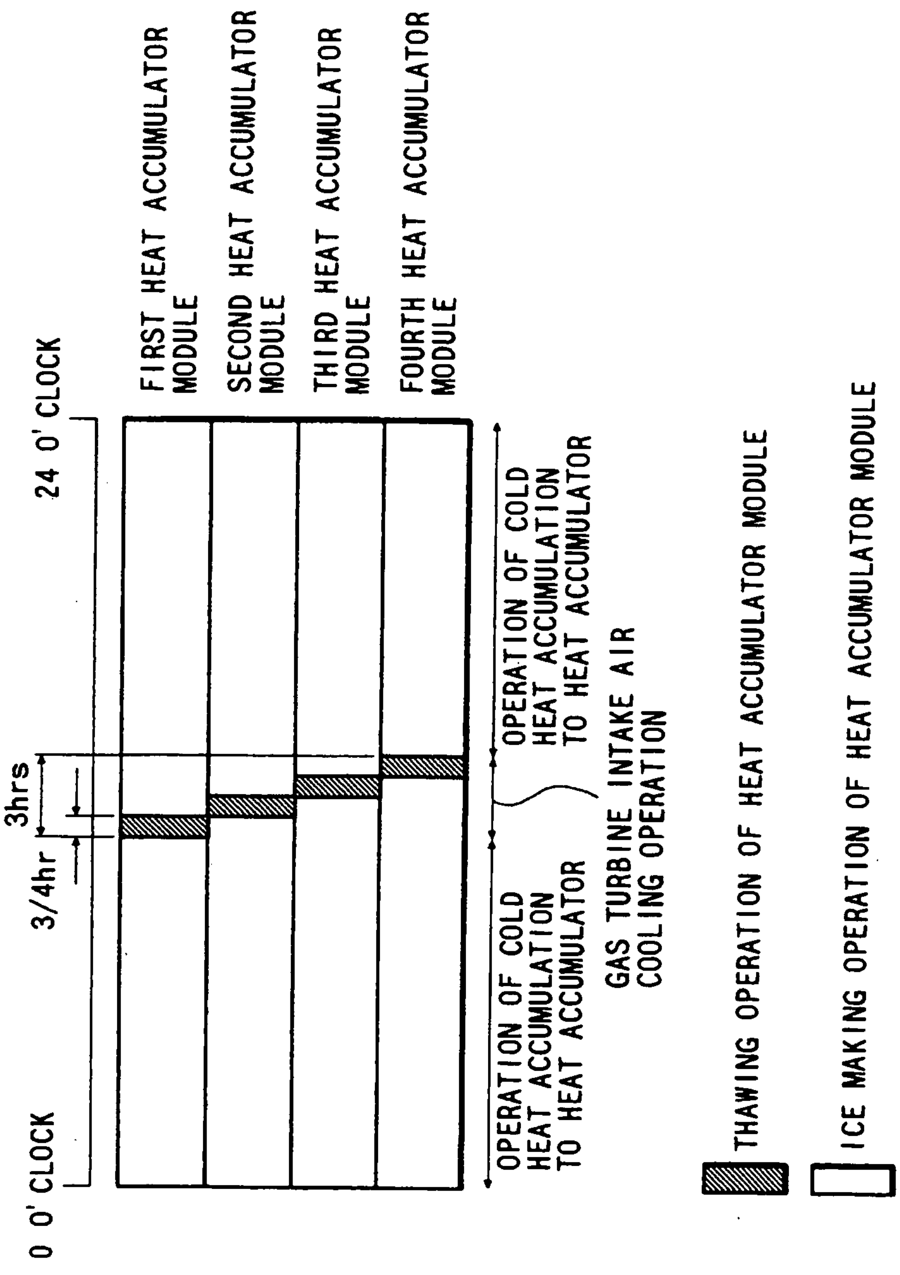

10
13
14
12
9a
24
18
22
21
20
19
92
91
8a
23
71
72
72
71
CLOSE
OPEN
7a
11
30
4
5
6
3
2

FIG. 7


0 0' CLOCK
3/4hr
3hrs
24 0' CLOCK
FIRST HEAT ACCUMULATOR MODULE
SECOND HEAT ACCUMULATOR MODULE
THIRD HEAT ACCUMULATOR MODULE
FOURTH HEAT ACCUMULATOR MODULE
OPERATION OF COLD HEAT ACCUMULATION TO HEAT ACCUMULATOR
GAS TURBINE INTAKE AIR COOLING OPERATION
OPERATION OF COLD HEAT ACCUMULATION TO HEAT ACCUMULATOR
THAWING OPERATION OF HEAT ACCUMULATOR MODULE
ICE MAKING OPERATION OF HEAT ACCUMULATOR MODULE